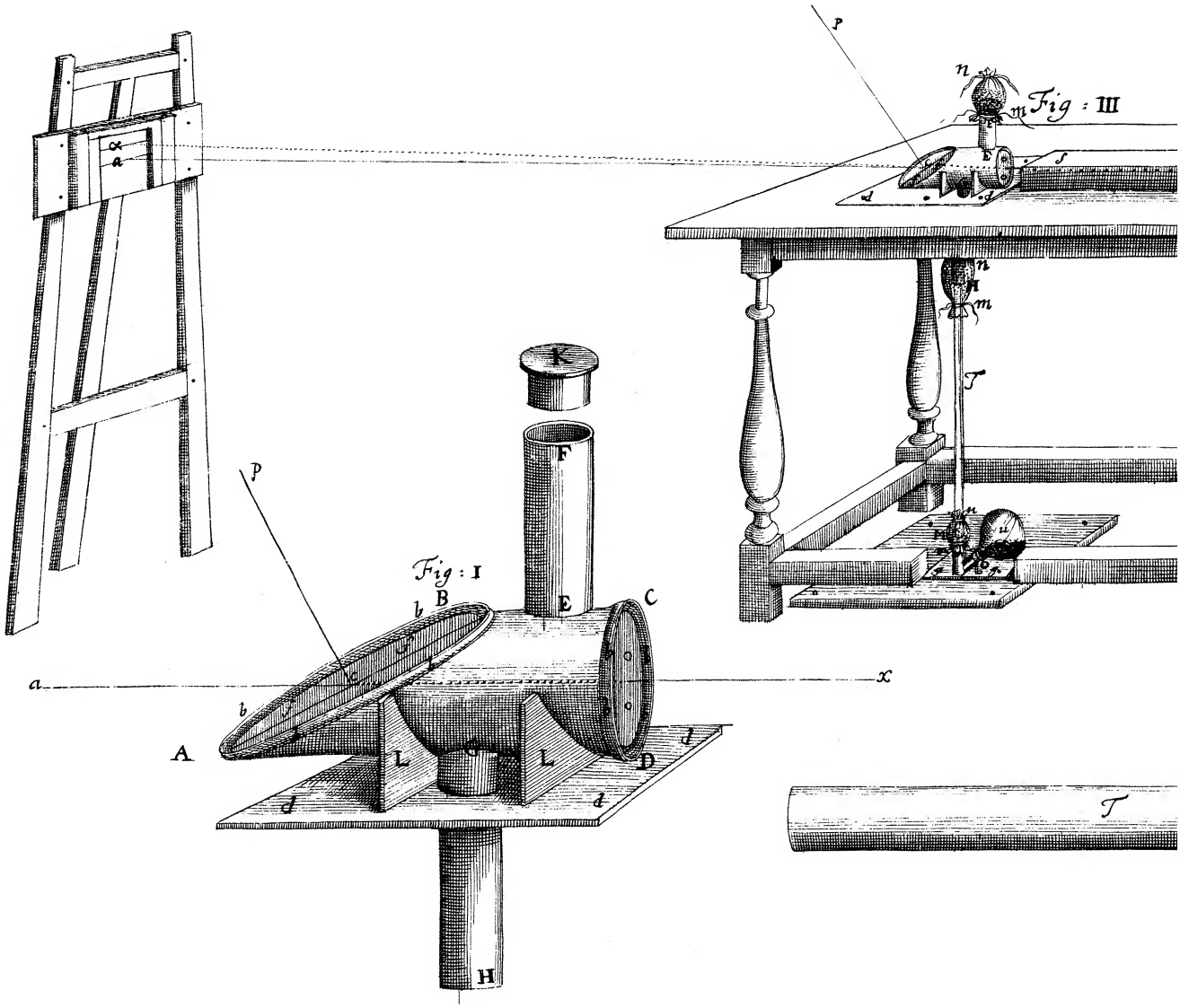


Fig : III
Fig : I
P
K
F
E
C
B
b
A
L
D
d
H
a
x
T

III

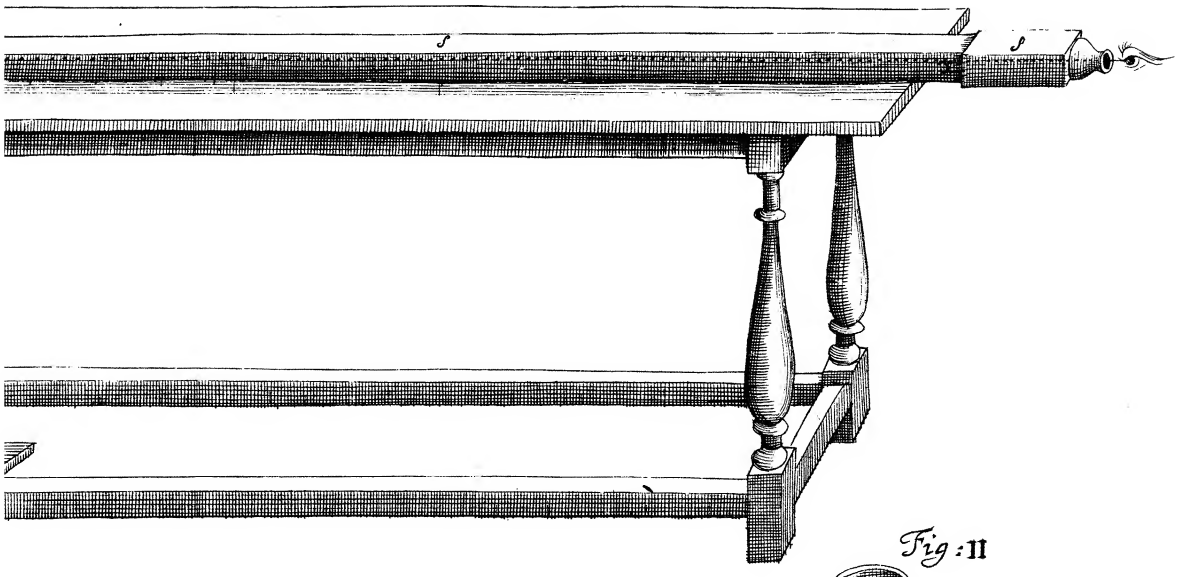
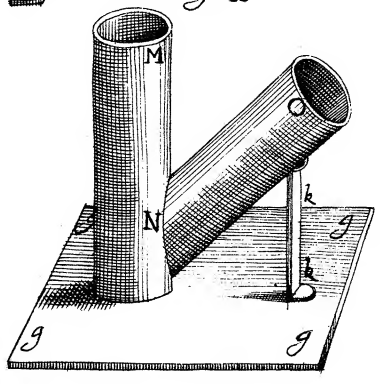


Fig : II



PHILOSOPHICAL TRANSACTIONS.

For the Month of *October*, 1699.

The CONTENTS.

I. *An Experiment of the Refraction of the Air made at the Command of the Royal Society*, Mar. 28. 1699. *By* J. Lowthorp. A. M.

WE took a Cylinder of Caſt-Braſs Fig. I. ABCD; and cut one end of it CD perpendicular to the Axis *ax*, the other end AB enclin'd to it at an Angle of about 27° 30′. and therefore the Perpendicular to this enclining plain, *pc*, and the Axis of the Cylinder *ax* comprehended an Angle *pca* of about 62*o*. 30*d*. Theſe ends were groun'd very true upon a Glaſs-Grinder's Braſs-Tool, and each of them was compaſt about with a narrow Ferule of thin Braſs *bbbb*. Into the upper ſide of the Cylinder at E was ſolder'd the Braſs pipe EF, and into the under ſide at 6 the other Braſs pipe GH; the former of theſe Pipes being about 3 inches long and the late 6 inches. Upon the plate *ddd* were fixt two other plates LL Perpendicular to it and parallel to each other. Each of theſe two plates had an Arch of a Circle (equal to the Circumference of the Cylinder) cut out of its upper Edge, ſo that when the pipe GH was let through a hole near the middle of the plate *ddd*, the Cylinder fell into the Arches; and being

faſten'd there with Soder, the Axis *ax* laid Parallel to the Plate *ddd* and about an inch and half above it. The Perpendicular End of the Cylinder DC was clos'd with an Object Glaſs of a 76*th*. Foot Teleſcope, *oo*; and the other End AB, with a well poliſht flat Glaſs *ff*; which was carefully choſen to tranſmit the Object diſtinct enough notwithſtanding its Obliquity to the Viſual Rays. The Ferules were well fill'd with Cement round about the Edges of the Glaſs, and they laid flat and every where toucht the ſmooth Ends of the Cylinder, that they might firmly reſiſt the preſſure of the Excluded Air.

Inſtead of a Ciſtern (as in the Torricellian Experiment) we made uſe of the Inverted Siphon of Braſs Fig. II. MNO, ſoder'd to the Plate *ggg*. One of the ſides MN ſtood Perpendicular to the plate, and the other ſide NO Enclin'd to it, and was ſupported near the upper End O with a little prop *kk*.

We then plac'd the Cylinder (as in Fig. III.) upon a Table which was well faſten'd to a firm Flore; The pipe GH was let through a Hole, and the Axis laid almoſt parallel to the ſides of the Table, and the Plate *ddd* was nail'd down to it. The Tube of the Teleſcope *ff* with the Eye glaſs was apply'd to the Object Glaſs, and a Hair fixt within it at the common Focus of both glaſſes in the Axis of the Cylinder continu'd, x. Upon the floore (under the Cylinder) we nail'd the plate *ggg* with the inverted Siphon upon it, and join'd M to H by the Inſection of the Glaſs Tube T. The joints were very carefully clos'd with Cement: And then they were cover'd over with pieces of a bladder and wrapt hard with ſtrong thread. There was alſo a bladder ty'd below each joint at *m*, and when it was fill'd with Water it was ty'd above it at *n*; So that no Air could come to the Cement or inſinuate it ſelf through it's pores or fiſſures if any happen'd to be left unclos'd.

It is not (I think) an unneceſſary trouble, that in this account of the Apparatus I have mention'd ſo many minute Circumſtances, for we found it difficult enough to exclude the Air, and almoſt Impoſſible to diſcover the very little holes through which ſo ſubtil a fluid would freely enter and poſſeſs the ſpaces deſerted by the ſubſiding Mercury. But with all this precaution the experiment ſucceeded at laſt, as I wiſht, after this manner.

We plac'd the Object *a* (which was a black thread ſliding in a little frame over a piece of white paper) in the Axis of the Cylinder *cx* continu'd to it; We fill'd the Pipes and Cylinder

linder with Mercury; and having ſtopt the uppermoſt Pipe at F with the little Iron ſtopple K and clos'd it at the other joints, we let the Mercury run out gently at O into the bladder *v*, till it remain'd ſuſpended at the uſual height (as in the Barometre) leaving the ſpace above it between the glaſſes *os* and *ff* void of Air. We then found the Object, which before appear'd in the Axis at *x*, rais'd conſiderably above it; and we reduc'd it to appear at *x* by removing it from *a* to *x*. The Axis therefore, of the viſual Ray *xa* (which was alſo the Axis of the Cylinder) *xa*, falling Perpendicularly on the void ſpace in the Cylinder paſt through it without any Refraction: But emerging obliquely into the Air, it was Refracted towards the Perpendicular *pc*, and there receiv'd a new direction to *x*. And therefore the ſpace *ax* ſubſtended the Angle of Refraction *acx*; which we meaſur'd and found as follows.

The height of the Object above the Axis of viſual Ray *ax* the unrefracted ——	inches depths 0, 425
The Diſtance of the Object from the Refracting Plain, *&c.* about 51 feet or	612
Therefore the Angle of Refraction *acx* was	0. 2′. 23′
The Angle of Emerſion *pca* (by the conſtruction of the Cylinder) was	62. 30.
Therefore the Angle of Incidence *pcx* (= *pca* + *acx*) was	62. 27. 37.
And therefore univerſally (according to the known Laws of Refraction)	
The ſines of the Angles of Incidence being	100000
The ſines of the Angles of Emerſion are	100036
And the Refractive Power of the Denſe Air	36

By the Refractive Power of a Pellucid body I mean that Properly in it whereby the Oblique Rays of Light are diverted from their direct Courſe; and which is meaſur'd by the Proportional Differences always Obſerv'd between the ſines of the Angles of Incidence and Emerſion.

This *Property* is not always proportional to the *Denſity* (at leaſt not to the Gravity) of the Refracting Medium. For the Refractive power of Glaſs to that of Water is as 55 to 34. whereas its Gravity is as 87 to 34; that is, the ſquares of their Refractive *Powers* are (very near) as their reſpective Gravities. And there are ſome fluids which tho lighter than Water

yet

yet have a Greater *Power* of Refraction; thus the Refractive *Power* of Spirit of Wine (according to Dr. *Hooks* Experiments) Microg. p. 220) is to that of Water as 36 to 33 and it's Gravity reciprocally as 33 to 36 or $36\frac{1}{11}$. But the Refractive *Powers* of Air and Water ſeem to obſerve the ſimple *Proportion* of their Gravities, directly; as I have compar'd them in the following Table. The Numbers there Expreſſing the Refraction of Water are taken from the mean of *9 Obſervations at ſo many ſeveral Angles of Incidence made *Jan.* 25. $164\frac{8}{11}$ by Mr. *Gaſcoigne* the Ingenious Fire Inventor of the Micrometer, and the ways of meaſuring Angles by Teleſcopes and thoſe of Air are produc'd by the Experiment above related, *&c.*

* *I am Indebted for them to Mr.* Flamſteed, *who had cover'd them with his Obſervations, and ſeveral paſſages relating to them, from his Letters to Mr.* Crabtree *which were happily preſerv'd in the time of our Civil War by Sr.* Jonas Moor *and Mr.* Chriſtopher Towneley; *and are now in the Hands of Mr.* Richard Towneley *of* Towneley *in* Lancaſhire, *by whom they were imparted to him.*

	Water.	*Air.*
The (aſſum'd) ſines of the Angles of Incidence through	100000.	100000
The ſines of the correſpondent Angles of Emerſion out of	134400.	100036
The Refractive power of	34400	36
The Specifick Gravity (if as 900 to 1 at the time of the Experiment) of	34400	38
or (if as 850 to 1) of		40

From hence it ſeems very probable that their Reſpective Denſities and Refractive Powers are in a juſt ſimple proportion: And if this ſhould be confirm'd by ſucceeding Experiments made at different Angles of Incidence and with Cylinders continuing Exhauſted through ſeveral Changes of the Air it would be more than probable that the Refractive Powers of the Atmoſphere are every where, at all heights above the Earth, proportional to it's Denſities and Expanſions. And here it would be no difficult matter to trace the Light through it, thereby to terminate the ſhadow of the Earth; and (together with proper Expedients for meaſuring the Quantity of Light Illuminating an Opaque Body) to Examin at what diſtances the Moon muſt be from the Earth to ſuffer Eclipſes of the Obſerv'd *Duration*. This Limitation is conſiderable enough in Aſtronomy, abundantly to recompenſe the trouble of Proſecuting ſuch a New Experiment.

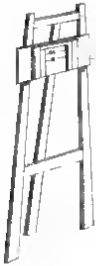


Fig. III

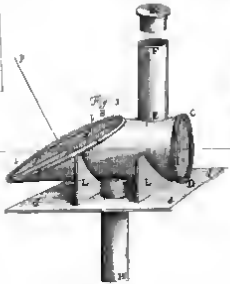


Fig. II